Supporting Information

Cu Doped Black Phosphorus Quantum Dots as Multifunctional Fenton Nanocatalysts for Boosting H₂O₂-Guided and Photothermal Synergistically

Enhanced Cancer Chemodynamic Therapy

Haimei Li,^a Yaofa Liu,^d Shulan Li,^c Silong Zhang,^a Biao Huang,^d Ran Cui,^d Yi Liu*^{a,c,d} and Peng Jiang*^b ^aKey Laboratory of Coal Conversion and New Carbon Materials of Hubei Province & Institute of Advanced Materials and Nanotechnology, College of Chemistry and Chemical Engineering, Wuhan University of Science and Technology, Wuhan 430081, P. R. China ^bKey Laboratory of Combinatorial Biosynthesis and Drug Discovery, Ministry of Education, and Wuhan University School of Pharmaceutical Sciences, Wuhan 430071, P. R. China ^cState Key Laboratory of Separation Membrane and Membrane Process, School of Chemistry and Chemical Engineering & College of Environmental Science and Engineering, Tiangong University, Tianjin 300387, P. R. China ^dSauvage Center for Molecular Sciences, College of Chemistry and Molecular Sciences, Wuhan

University, Wuhan 430072, P. R. China

Corresponding Authors

*E-mail addresses: yiliuchem@whu.edu.cn; jiangpeng@whu.edu.cn



Figure S1. TEM characterization. (a) HR-TEM images of BPQDs and (b) BPQDs-Cu. (c) Particle size distribution curve of BPQDs. (d) Particle size distribution curve of BCG NPs.



Figure S2. (a) High-resolution XPS P 2p spectra of BPQDs, and (b) Cu 2p spectra.



Figure S3. (a) UV absorption spectra of MB and BCG NPs-Glu mixed solution under different incubation times. (b) Fluorescence spectra of TA and BCG NPs-Glu mixed solution under different incubation times. BCG NPs=100 μ g mL⁻¹, Glu=5 mM.



Figure S4. (a) FT-IR spectra of commercial GSSG and the reaction product. (b) ¹H NMR of the reaction product in D₂O. Black line, commercial GSSG; red line, reaction product in D₂O. (c) HRMS of the reaction product in D₂O.



Figure S5. (a) UV-Vis-NIR absorbance spectrum of 0.25 M CuSO₄ in doubledistilled water (ddH₂O). (b) The absorbance spectra of BPQDs and BP-Cu in ddH₂O after 24 hours incubation at room temperature.



Figure S6. (a) Photothermal curves for different concentrations (50, 100, 200 μ g mL⁻¹) of BPQDs under the irradiation of 808 nm laser with a power density of 1 W cm⁻². (b) Temperature curves for the same concentration of BPQDs (100 μ g mL⁻¹) at 0.5 W cm⁻², 1.0 W cm⁻², 1.5 W cm⁻² power densities. (c) Photothermal cycle measurement for the BPQDs.



Figure S7. Heating and cooling curves of solution of (a) BPQDs, (b) BPQDs-Cu, (c) BPQDs-Cu@GOD nanoparticles under the NIR irradiation (808 nm, 1.0 W cm⁻²). Inset: Linear fitting curve of BPQDs, BPQDs-Cu, BPQDs-Cu@GOD nanoparticles from the highest temperature to room temperature.



Figure S8. Fluorescence image of JC-1 stained mitochondrial membrane potential. Scale bar: 50 μm.



Figure S9. The image of tumor-bearing mice in different treatment schemes.



Figure S10. H&E stained images of various main organs of mice treated with different methods after 16 days Scale bar: 100 μm.

	Normal Range	Control	Control +NIR	BPQDs-Cu	BPQDs-Cu +NIR	BCG NPs	BCG NPs +NIR
WBC (10 ⁹ L ⁻¹)	0.8~6.8	88.2±8.1	69.2±6.3	73.3±25.6	58.3±15.4	7.8±1.6	3.8±0.5
Lymph (10 ⁹ L ⁻¹)	0.7~5.7	67.2±14.2	61.5±12.5	34.5±13.7	35.1±7.3	5.6±1.0	3.2±0.6
Mon (10 ⁹ L ⁻¹)	0~0.3	3.4±1.59	1.3±0.6	5.2±1.4	3.6±0.9	0.4±0.1	0.1 ± 0.1
Gran (10 ⁹ L ⁻¹)	0.1~1.8	17.8±5.7	6.4±11.1	33.6±10.8	19.6±7.3	1.9±0.6	0.5±0.2
RBC (10 ¹² L ⁻¹)	6.36~9.42	7.96±1.4	7.95±1.6	11.08±4.4	7.4±4.8	12.4±5.1	9.18±1.7
HGB (g L ⁻¹)	110~143	120±18.6	155±23.3	163±12.9	110±8.2	203±18.6	142±36.3
НСТ (%)	34.6~44.6	37.1±9.3	35.5±5.6	52.9±0.6	35.5±3.0	60.1±4.3	43.7±9.2
MCV (fL)	48.2~58.3	49.2±4.1	40.9±11.5	49.6±8.7	50.7±16.6	50.1±13.3	48.8±8.5
MCHC (g L ⁻¹)	302~353	306±82.5	476±85.5	296±51.1	293±15.8	326±24.9	317±15.0
RDW (%)	13~17	14.4±9.3	34.2±8.4	14.4±5.7	14.8±3.2	13.8±3.7	13.7±1.6
PLT (10 ⁹ L ⁻¹)	450~1590	880±52.2	984±70.3	106±64.8	743±102.0	841±50.6	808±84.6

Table S1. Hematological analysis^{a)} of 4T1 tumor-bearing mice after 16 days of different treatments.

^{a)} The recording items are white blood cells (WBC), Lymphocytes (Lymph), Monocyte (Mon),

neutrophilicgranulocyte (Gran), red blood cells (RBC), hemoglobin (HGB), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RDW) and platelets (PLT)